

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. An aluminum ingot casting machine comprising:
5 a source of molten metal;
a rotatable annular ring, said annular ring having a generally
vertical axis of rotation and being sized and shaped to carry a
plurality of ingot casting moulds; and
10 a drive means for indexing said moulds to said source of
molten metal by rotating said annular ring.
2. An aluminum ingot casting machine as claimed in claim 1,
wherein said annular ring includes a mould-carrying carousel and a
support structure supporting the carousel.
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3. An aluminum ingot casting machine as claimed in claim 2
wherein the support structure includes an inner and an outer circular
rail for supporting the carousel and a plurality of floor mounted
support rollers to support said circular rails.
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4. An aluminum ingot casting machine as claimed in claim 2
wherein the support structure comprises a floor-mounted inner and
a floor-mounted outer circular rail, and a plurality of rollers, supported
by said rails, supporting said carousel.
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5. An aluminum ingot casting machine as claimed in claim 2
wherein said drive means acts between said floor and said carousel,
to rotate said annular ring on said support structure.
- 30 6. An aluminum ingot casting machine as claimed in claim 5
wherein the drive means includes a drive gear means fixed to one of
said circular rails, and a drive sprocket for driving said drive gear

means.

- 5 7. An aluminium ingot casting machine as claimed in claim 5, wherein the drive means includes a gear means fixed to the carousel, and a drive sprocket for driving the drive gear means.
- 10 8. An aluminium ingot casting machine as claimed in claim 6 or claim 7, wherein the drive gear means comprises a series of cam followers.
9. An aluminum ingot casting machine as claimed in claim 6, claim 7 or claim 8 wherein said drive sprocket is powered by an AC electric motor.
- 15 10. An aluminium ingot casting machine as claimed in claim 9, wherein said motor is controlled by a variable frequency controller.
- 20 11. An aluminum ingot casting machine as claimed in claim 1 wherein said source of molten metal includes at least two pivoting crucibles to permit continuous pouring of molten aluminum.
- 25 12. An aluminum ingot casting machine as claimed in claim 11 further including a Y-shaped launder extending between said crucibles and said annular ring carousel.
13. An aluminum ingot casting machine as claimed in claim 12 further including a pivoting tundish.
- 30 14. An aluminum ingot casting machine as claimed in claim 13 wherein said pivoting tundish includes a ceramic nozzle for under pouring said molten metal in said moulds.

15. An aluminum ingot casting machine as claimed in claim 14 wherein said tundish pivots between a lower pouring position and a raised non-pouring position.
- 5 16. An aluminum ingot casting machine as claimed in claim 15 further including an automatic skimming apparatus.
- 10 17. An aluminum ingot casting machine as claimed in claim 1 further including a water sprayer cooling system located below said annular ring.
- 15 18. An aluminum ingot casting machine as claimed in claim 17 wherein said cooling system includes a plurality of nozzles for spraying water onto said moulds.
- 20 19. An aluminum ingot casting machine as claimed in claim 18 wherein said annular ring includes a steam retaining skirt extending downwardly therefrom.
- 20 20. An aluminum ingot casting machine as claimed in claim 18 or 19 wherein said nozzles are located above a water tray located beneath the annular ring.
- 25 21. An aluminum ingot casting machine as claimed in claim 20 wherein said water tray includes an upstanding side wall which is curved in plan view to follow said annular ring and said water tray includes a certain level of water therein.
- 30 22. An aluminum ingot casting machine as claimed in claim 21 wherein said steam retaining skirt extends below said level of water contained within said water tray wherein steam is trapped below said annular ring by said steam retaining skirt.

23. An aluminum ingot casting machine as claimed in claim 22 wherein said water tray includes end walls which define a water free region below said annular ring, said water free region being sized and shaped to permit the pouring and skimming of ingots.
24. An aluminum ingot casting machine as claimed in claim 23 wherein said end walls include slots to permit said steam retaining skirt to pass through said end walls.
25. An aluminum ingot casting machine as claimed in claim 24 wherein said slots are sized and shaped to control an amount of water that escapes from said water tray through said slots.
26. An aluminum ingot casting machine as claimed in claim 25 further including a collection tray to capture water which escapes from said slot for recirculation.
27. An aluminum ingot casting machine as claimed in claim 17 wherein said water spray cooling system is sized to permit different amounts of cooling to be provided at different positions around said annular ring.
28. An aluminum ingot casting machine as claimed in claim 11 wherein said crucibles are removably placed in tilter frames.
29. An aluminum ingot casting machine as claimed in claim 28 wherein said tilter frames include latches to retain the crucibles to the tilter frames when in use.
30. An aluminum ingot casting machine as claimed in claim 28 wherein said tilter frames include actuators to tilt the crucibles to pour

molten metal into said launder.

- 5 31. An aluminum ingot casting machine as claimed in claim 28 wherein said tilter frames further include an encoder to measure a tilt position of said crucibles.
- 10 32. An aluminum ingot casting machine as claimed in claim 31 further including an automatic control for tilting said crucibles in a controlled manner for pouring, based on said position encoder.
- 15 33. An aluminum ingot casting machine as claimed in claim 32 wherein said controlled manner pouring includes having an adjustor to vary a speed of tilting said crucibles to ensure an even rate of pour of molten metal into said moulds.
- 20 34. An aluminum ingot casting machine as claimed in claim 32 further including a manual control to allow an operator to tilt a crucible to a pouring point before turning on the automatic control.
- 25 35. An aluminum ingot casting machine as claimed in claim 28 wherein one crucible is larger than the other crucible.
- 30 36. An aluminum ingot casting machine as claimed in claim 28 wherein said tilting frame automatically returns to an untilted position in the event of a loss of power.
37. An aluminum ingot casting machine as claimed in claim 29 wherein said latches include a safety switch to prevent said automatic controller from moving the tilter frames if said latches are not secured.
38. An aluminum ingot casting machine as claimed in claim 32

wherein said automatic control causes a second crucible to start pouring upon said first crucible being finished to ensure a substantially continuous flow of molten metal.

- 5 39. An aluminum ingot casting machine as claimed in claim 16 wherein said skimming apparatus is sized and shaped to remove dross from a surface of each poured ingot, immediately after each ingot is poured.
- 10 40. An aluminum ingot casting machine as claimed in claim 39 wherein said skimming apparatus is located at a station adjacent to where said moulds are poured, in the direction of rotation of said annular ring.
- 15 41. An aluminum ingot casting machine as claimed in claim 40 wherein said skimming apparatus includes a replaceable spatula for skimming said dross.
- 20 42. An aluminum ingot casting machine as claimed in claim 41 wherein said station further includes at least one skim pot for discharging said skimmed dross from said spatula.
- 25 43. An aluminum ingot casting machine as claimed in claim 42 further including a proximity switch for detecting the presence of a mould requiring skimming.
- 30 44. An aluminum ingot casting machine as claimed in claim 42 wherein there are at least two skim pots with level sensors, and said skimming apparatus fills first one then the other of said skim pots to permit a full skim pot to be removed and emptied.
45. An aluminum ingot casting machine as claimed in claim 44

further including a preheater to preheat the spatula prior to skimming.

46. A vacuum seal arrangement for use on a vacuum lifting head for lifting metal ingots, said vacuum lifting head having a source of vacuum, said vacuum seal arrangement comprising:
- 5 a sealing element having a flexible core which can deform to form a vacuum seal against an ingot and a flexible abrasion-resistant outer layer on said core, and
- 10 one or more retaining elements located on a lower face of said lifting head for releasably retaining said sealing element onto the lifting head.
47. A vacuum seal arrangement for lifting ingots as claimed in claim 46 wherein said sealing element is generally rounded in cross section and has a diameter, and said one or more retaining elements
- 15 include a pair of opposed flanges which are angled towards one another.
48. A vacuum seal arrangement for lifting ingots from moulds as claimed in claim 47 wherein said flanges include outer edges which
- 20 are more than one half of the seal diameter from the lifting head, but less than one seal diameter.
49. A vacuum seal arrangement for lifting ingots from moulds as claimed in claim 46 wherein said one or more retaining elements are
- 25 sized and shaped to retain said sealing element on said lifting head without requiring separate fasteners.
50. A vacuum seal arrangement for lifting ingots from moulds as claimed in claim 46 wherein said sealing element is deformable to fit
- 30 between said retaining elements and said retaining elements are sized and shaped to retain said sealing element on said lifting head

when said sealing element is not deformed.

51. A vacuum seal arrangement as claimed in claim 46, wherein the sealing element is shaped and positioned so as to define a vacuum lifting area free of sharp corners.
52. A vacuum seal arrangement as claimed in claim 51, wherein the vacuum lifting area is generally circular in shape.
53. A vacuum seal arrangement as claimed in claim 51, wherein the vacuum lifting area is generally oval in shape.
54. A vacuum seal arrangement as claimed in claim 46, wherein the arrangement further comprises at least one seal compression limiter sized, shaped and positioned on said lifting head so as to limit the compression of said sealing element when said vacuum seal is formed against said ingot.
55. A vacuum seal arrangement as claimed in claim 54, wherein the arrangement comprises four seal compression limiters.
56. A vacuum seal arrangement as claimed in claim 54, wherein said at least one limiter is adjustable to adjust the compression limit of the sealing element.
57. A vacuum seal arrangement as claimed in claim 56, wherein said at least one seal compression limiter is threaded, and wherein said lifting head includes at least one threaded hole for receiving the at least one seal compressions limiter, the at least one limiter being adjustable by rotating the at least one limiter in the at least one threaded hole.

58. A vacuum seal arrangement as claimed in claim 46, 47, 48, 50, 51, 54 or 56, the arrangement comprising a single retaining element, the retaining element comprising a pair of opposed, continuous steel flanges, said retaining element defining a closed shape.

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59. A vacuum seal for use in a lifting head having a source of vacuum sufficient to lift ingots from moulds, said vacuum seal comprising a flexible ring shaped body, being rounded in cross section, having a fibre cord core and an abrasion resistant flexible sheathing surrounding the core.

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60. A vacuum seal for use in an ingot lifting head as claimed in claim 59 wherein the fibre cord core is made from a high temperature resistant material.

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61. A vacuum seal for use in an ingot lifting head as claimed in claim 59 wherein said abrasion resistant sheathing is a flexible stainless steel mesh.

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62. An aluminum ingot casting machine as claimed in claim 1, wherein the machine further comprises a demoulder means for transferring ingots from said moulds and a cooling line for cooling ingots, positioned to receive said ingots from said demoulder means, said cooling line including:

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a conveyer for moving said ingots along said cooling line;

a cooling tunnel for enclosing said conveyer;

a source of cooling water to spray said ingots moving within said cooling tunnel; and

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a countercurrent air flow to provide additional heat exchange with said cooling ingots.

63. A machine as claimed in claim 62 wherein said conveyer is a walking beam conveyer, having a walking rail and a stationary rail.

5 64. A machine as claimed in claim 63 wherein said walking rail is moved by a hydraulic actuator.

65. A machine as claimed in claim 62, wherein said cooling line further includes entrance and exit air knives on said cooling tunnel for removing extraneous matter from said ingots.

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